(2)

IDA PAPER P-2343

NEW ACCOUNTING SYSTEMS AND THEIR EFFECTS ON DoD COST ESTIMATING

John J. Cloos, *Project Leader*
James D. McCullough

December 1989

INSTITUTE FOR DEFENSE ANALYSES
1801 N. Beauregard Street, Alexandria, Virginia 22311-1772

IDA Log No. HQ 89-34978

DEFINITIONS

IDA publishes the following documents to report the results of its work.

Reports

Reports are the most authoritative and most carefully considered products IDA publishes. They normally embody results of major projects which (a) have a direct bearing on decisions affecting major programs, (b) address issues of significant concern to the Executive Branch, the Congress and/or the public, or (c) address issues that have significant economic implications. IDA Reports are reviewed by outside panels of experts to ensure their high quality and relevance to the problems studied, and they are released by the President of IDA.

Group Reports

Group Reports record the findings and results of IDA established working groups and panels composed of senior individuals addressing major issues which otherwise would be the subject of an IDA Report. IDA Group Reports are reviewed by the senior individuals responsible for the project and others as selected by IDA to ensure their high quality and relevance to the problems studied, and are released by the President of IDA.

Papers

Papers, also authoritative and carefully considered products of IDA, address studies that are narrower in scope than those covered in Reports. IDA Papers are reviewed to ensure that they meet the high standards expected of refereed papers in professional journals or formal Agency reports.

Documents

IDA Documents are used for the convenience of the sponsors or the analysts (a) to record substantive work done in quick reaction studies, (b) to record the proceedings of conferences and meetings, (c) to make available preliminary and tentative results of analyses, (d) to record data developed in the course of an investigation, or (e) to forward information that is essentially unanalyzed and unevaluated. The review of IDA Documents is suited to their content and intended use.

The work reported in this document was conducted under contract MDA 903 89 C 0003 for the Department of Defense. The publication of this IDA Paper does not indicate endorsement by the Department of Defense, nor should the contents be construed as reflecting the official position of that Agency.

This Paper has been reviewed by IDA to assure that it meets the high standards of thoroughness, objectivity, and appropriate analytical methodology and that the results, conclusions and recommendations are properly supported by the material presented.

UNCLASSIFIED

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave blank)*	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	December 1989	Final Report, Dec 1988 – Dec 1989

4. TITLE AND SUBTITLE
New Accounting Systems and Their Effects on DoD Cost Estimating

5. FUNDING NUMBERS
Independent Research Program

6. AUTHOR(S)
John J. Cloos and James D. McCullough

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Institute for Defense Analyses
1801 N. Beauregard Street
Alexandria, VA 22311-1772

8. PERFORMING ORGANIZATION REPORT NUMBER
IDA-P-2343

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
N/A

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12A. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited.

12B. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

Traditional cost accounting recently has been the object of extensive criticism because of its inadequate representation of manufacturing costs. New accounting approaches are being proposed and tested that will improve the information provided to managers in both industry and government. These new approaches will lead to evolutionary changes in the data and methodologies used by cost analysts. This paper describes the evolution in manufacturing processes, accounting systems, and cost estimating. Recommendations on how to prepare for this changing environment are offered to the DoD cost estimating community.

14. SUBJECT TERMS
Costs, Weapon Systems, Accounting, Cost Estimates

15. NUMBER OF PAGES
42

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	SAR

NSN 7540-01-280-5500

Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Std. Z39-18
298-102

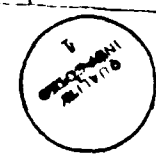
UNCLASSIFIED

IDA PAPER P-2343

NEW ACCOUNTING SYSTEMS AND THEIR EFFECTS ON DoD COST ESTIMATING

John J. Cloos, *Project Leader*
James D. McCullough

December 1989



INSTITUTE FOR DEFENSE ANALYSES

IDA Independent Research Program

PREFACE

This paper was prepared by the Institute for Defense Analyses (IDA) for IDA's Independent Research Program, under contract MDA 903 89 C 0003. The objective of the project was to investigate current efforts to improve industrial cost accounting systems and to identify the possible effects on DoD cost estimating

This paper was reviewed by Stanley A. Horowitz, Robert H. Simmons, and Stephen J. Balut, all of IDA's Cost Analysis and Research Division (CARD).

CONTENTS

TABLES

FIGURES

I. INTRODUCTION

Cost accounting systems are said to be changing in response to the modernization of manufacturing technology. How and when will these changes affect weapon system cost estimation? This paper examines those questions. First, detailed information is provided on the evolution of industrial cost accounting systems and their culmination with activity-based accounting (ABA). Second, the potential effect of ABA on the process of estimating weapon system costs is investigated. Finally, recommendations are made to guide the cost analyst in preparing for the advent of ABA.

A. BACKGROUND

The manufacturing environment is continuing to change as companies implement new technologies and related management philosophies. The cost accounting systems designed to mirror the manufacturing process have not kept pace with the changes. As a result, in the last few years, there has been increasingly widespread criticism of modern cost accounting as an effective and relevant management tool. Many influential leaders in academia, industry, and the business consulting community have been proposing new accounting systems to help managers improve the manufacturing process. The new systems and the attendant potential for better information could have important implications for many disciplines. The Department of Defense (DoD) cost estimating function is one such discipline that relies heavily on cost accounting data.

DoD cost estimating is an integral part of the resource allocation process used throughout the planning, programming, budgeting, and execution of the defense program. It is used to predict resource costs for a wide variety of defense needs such as total forces, manpower, weapon systems, and logistics. The focus of this paper is on estimating costs for DoD weapon systems. The vast majority of these costs are incurred in the private industrial sector by defense contractors, who use industrial accounting systems to capture resource costs associated with the manufacturing process. Costs are aggregated both for external parties and for internal management. The contractors report these manufacturing costs in prescribed formats to DoD, which, in turn, uses them for multiple purposes such

as contract payment, future contract negotiations, cost performance assessment, and cost estimating. Defense industry cost accounting in support of government contracts is governed by the requirements contained in the Federal Acquisition Regulations (FAR), related defense supplements to the FAR, and the Cost Accounting Standards (CAS).

B. COST ESTIMATING AND THE NEED FOR DATA

Cost estimating is a process designed to forecast the expected resources and dollar cost associated with the acquisition of a specific item or the performance of a designated task. A major function within the defense community is that of weapon system cost estimating, wherein life cycle costs are estimated that include the production costs to be incurred at a manufacturing plant, both for the initial acquisition of, say, aircraft and spares and follow-on spare parts. There are a number of different cost estimating methodologies that can be used depending upon the particular situation regarding the type of product, program maturity, availability of data, and time constraints. Estimates can generally be categorized as "top down" or "bottom up" with each having a variety of methodologies to choose from. Top down starts at the highest level of aggregation for the object being estimated and may proceed, as appropriate, down to lower levels of detail. Bottom up starts at the detail levels and successively builds the estimate to the desired level of aggregation. Table 1 provides a summary of the two estimating approaches and indicates when they are typically used in the life cycle of a weapon system.

Top down or parametric estimating is the most general cost estimating approach, and is ordinarily used during the conceptual, demonstration/validation, and early development stages. During these periods, specific detail data regarding performance and technical characteristics are typically lacking. Parametric estimates are also used when time constraints prohibit a detailed estimate or as an additional check on the detailed estimate. Parametric estimating uses cost estimating relationships (CERs) to represent the statistical relationship between costs and cost drivers, i.e., those factors that cause costs to change. Cost drivers for parametric cost estimating are typically of two forms:

- physical characteristics (e.g., weight, volume, density, material content)
- performance characteristics (e.g., speed, range, payload, thrust)

Table 1. Weapon System Cost Estimating Approaches

Approach	When Used
Parametric (top down) Cost estimating relationships (CERs)	Program Stage: conceptual, demonstration/validation, early development
Analogy	OR
	Time limitations
	Comparison to other methods
Detailed (bottom up) Uses material costs, labor hours and rates, overhead rates, facility costs and equipment	Full scale development, production
Fixed and variable cost analysis	

Information about these cost drivers is generally obtained from non-accounting sources such as engineering records. However, the cost data bases used to build the estimating relationships are usually derived from the cost accounting system.

Costs can also be estimated based on comparison (analogy) with systems that have the same general physical or operating characteristics. The DoD estimating methodology for a particular weapon system usually employs a combined CER and general analogy approach. Cost data bases are compiled based on groupings of similar systems, e.g., fighter aircraft or bombers. The data base for a particular grouping would then be used to develop appropriate CERs to apply to the system being estimated. For example, a conceptual advanced fighter aircraft would be estimated using parametric methods.

As the program matures and the system design becomes better defined (including drawings, specifications, and part lists), cost estimating methodologies gradually shift to the bottom up approach. These methods are commonly referred to as detailed, engineering, and manufacturing estimates. Estimates are prepared based on specific requirements for labor, tooling, material, and additional capital items. These requirements are translated into dollar costs by applying material costs, labor rates, and overhead rates to each of the items. The bottom up approach uses the detailed output of the cost accounting system. For the systems with detailed designs available, but which are not yet in production, the cost

analyst would rely on cost accounting records of similar systems (such as Grumman analysts might do for a new version of the F-14).

Eventually, actual production cost data would become available on a system. At that point, the bottom up method is the preferred method, utilizing the output of the cost accounting system. For example, estimates of the program plan for the F-14 would utilize the production history to date. Cost drivers for the bottom-up method are often available from the cost accounting system (or the accompanying industrial engineering records). Such drivers are activities associated with the production process (e.g., engineering hours, manufacturing hours, materials handling, and storage hours).

An important quantitative technique used in estimating costs is the learning curve, which is also referred to as the cost improvement, cost or time reduction, or experience curve. The learning curve can be used in both top-down and bottom-up estimating. The manufacturing process for DoD weapon systems typically involves repetitive activities occurring over a period of several years. A key quantitative technique included in cost estimating methodologies for resources required in a manufacturing operation is the application of the learning curve theory to the estimate. The theory applies only to recurring costs and is predicated on direct labor becoming progressively more efficient as production volume increases. When accomplishing a process on a repetitive basis, learning occurs and the experience gained often results in reduced costs. The learning curve theory asserts that learning takes place in a constant and predictable pattern. For each twofold increase in quantities produced, the labor hours needed to produce the marginal (doubled) quantity is less than the hours required to produce the previous base quantity. This proportional difference is referred to as the rate of learning.

Although the learning curve is primarily driven by direct labor, the rate of learning, in effect, includes both process and material procurement cost improvements. Changes such as flow process, set-up times, and work simplification all contribute to time and cost reduction. The learning curve, which also is based on historical costs, has been used successfully to predict engineering and manufacturing hours, material costs, and hardware costs needed to produce a specific quantity of a particular weapon system.

One other significant point is worth noting about the relationship between parametric and detailed estimating. A hybrid estimating approach, which combines parametric and detailed estimating, is often used for a particular weapon system. For

example, if sufficient information is not available at the detail level for a particular element of the estimate, a parametric estimate may be appropriately substituted.

C. ACCOUNTING TO ESTIMATING: A NEED FOR CHANGE?

Activity-based accounting (ABA) is intended to fill a management and accounting need for more accurate and useful information about the entire manufacturing process. Current accounting and estimating systems have difficulty collecting and forecasting reasonably accurate costs particularly in the case of multiproduct plants. ABA also could be very effective in providing the cost analyst with accurate production cost data in plants where new technologies have been implemented. Without ABA, the analyst may use misleading cost data furnished by current accounting systems that focus on direct labor.

This paper examines the proposed new ABA cost accounting systems from the viewpoint of the weapon system cost analyst. What changes will ABA bring about in the way production costs are accumulated and attributed to weapon system parts, production lots, and whole contracts in a multi-contract plant? What cost elements will be identified under ABA? Will direct labor still be one of the important cost elements? What cost drivers will be available from ABA records that the cost analyst can use? What will be the timing of ABA implementation? That is, how long from today does the cost analyst have to prepare for the coming of ABA? What actions can the cost analyst take to ensure adequate preparation for ABA? We seek answers to these questions in the sections that follow.

II. ACCOUNTING AND MANUFACTURING

Up until the last 20 years, American manufacturers were the dominant forces in the marketplace [1]. Until the early 1970s, the twentieth-century American manufacturing environment consisted of a large domestic marketplace that was basically free from foreign competition. During this period, American industry ordinarily tried to refine and improve existing manufacturing processes rather than investing heavily in new manufacturing technology. Substantial advances in technology were usually made in conjunction with plant expansion to meet increasing demand. When growth began levelling off in the 1970s, many firms could not justify investments in modernization. The emergence of foreign competition occurred about the same time, which further reduced the American market share.

In recent years, American firms have been increasing their investments in technology and exploring new management approaches to compete on a worldwide basis. Management information systems, such as cost accounting, must provide the needed data about the new environment.

In this chapter, we review both the cost estimator's and the cost accountant's need to understand the manufacturing process. We then describe the evolution of traditional accounting in its role as the financial mirror of the manufacturing process.

A. UNDERSTANDING THE MANUFACTURING PROCESS

Costs represent assets that are being used up or declining in value. These expiring assets or costs must be identified, collected, classified, and summarized for financial reporting based on the type of resource input being measured. Cost information must adequately describe the organization's internal operations so that it can be used effectively in the planning, managing, and controlling processes.

Cost accounting and cost estimating are interrelated processes designed to measure the actual and prospective consumption of resources, respectively. To effectively perform either of these functions in weapon system procurement requires knowledge and

understanding of the underlying production process. The cost accountant must thoroughly understand manufacturing in order to properly construct an accounting system. The cost estimator must also be very familiar with the process or alternative processes for two reasons. First, the analyst should know what resource inputs are required to produce the specific weapon systems over various quantity ranges. Secondly, the estimator must know enough about the process to evaluate the utility of cost accounting data and to identify and obtain information that is needed about the process but is not routinely collected, i.e., cost drivers that are either physical or performance characteristics.

An example of the cost estimators' need for manufacturing knowledge can be found in the application of the previously described learning curve or cost improvement theory. In using cost estimating methods dependent on historical costs, the estimator must accommodate substantive changes in the manufacturing environment such as advances in technology. This may result in altering the slope of the curve or inserting a step-down function that lowers the cost of the first theoretical unit produced. Obviously, these kinds of modifications necessitate that the analyst know the production process, including the extent of current and planned technology and any other significant initiatives that may affect costs.

B. ACCOUNTING: FINANCIAL AND MANAGEMENT

Accounting is primarily a system of collecting, analyzing, summarizing, and reporting quantitative information, largely financial, regarding the economic activities of an organization. There are two major types of accounting, financial accounting and managerial accounting, as shown in Figure 1. The primary attributes of each of these two systems is shown in Table 2.

Financial accounting provides information to parties outside of the organization such as shareholders, bankers, creditors, and the general public. It is based on a general set of ground rules common to many different businesses designed to promote objectivity, consistency, and comparability of data. These rules are largely formulated by the government (e.g., Internal Revenue Service, Securities and Exchange Commission) and the public accounting profession, which is principally represented and regulated by the American Institute of Certified Public Accountants (AICPA). The primary means

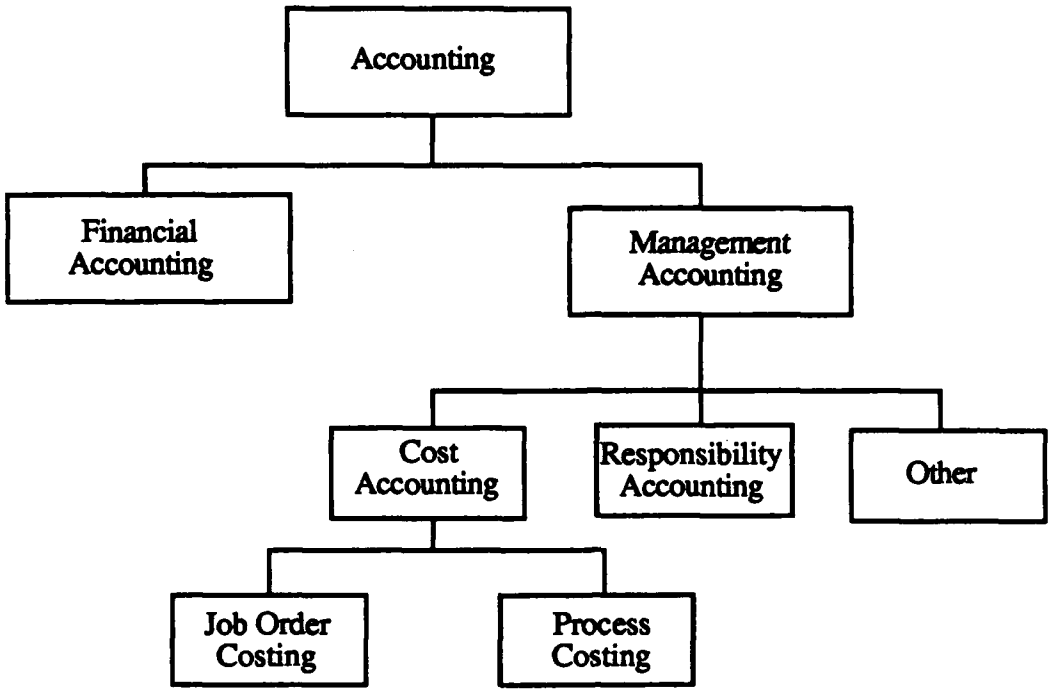


Figure 1. Accounting System

Table 2. Key Differences Between Financial and Management Accounting

Attributes	Financial Accounting	Management Accounting
Focus	External	Internal
	- Third Parties	- Management
Guidelines	Third Party Rules	Internal Needs
	- Government	
	- Professional	
Reporting Media	Financial Statement	What Management Wants
Reporting Period	Quarterly, Annual	When Management Wants
Orientation	Compliance with Rules	Adaptability to Management Needs
	-Third Party Audits	

of communicating the results of financial accounting are periodic statements, usually quarterly and annually, such as the balance sheet, income statement, and funds flow statement. A key underlying principle in financial accounting is that of compliance with the established rules that permeate asset valuation, liability recognition, equity determination, and income measurement. Major public companies are also subject to mandatory independent audits by outside parties to ensure compliance.

Management accounting provides information that is purportedly useful to management for their internal operations and decision making. Although it typically follows many of the same ground rules prescribed for financial accounting, management accounting has the added flexibility of establishing any rules it deems necessary to collect and tailor information to meet its individual needs.

The terms management accounting and cost accounting are often used interchangeably to describe the internal accounting system. In this paper we have elected to view cost accounting as a subset of management accounting; that is, the portion of management accounting that is primarily concerned with the determination of product costs. Management accounting can also include any other elements directed for management use and decision making in such areas as investments (capital budgeting), performance measurement (e.g., production cycle time), or responsibility center (organizational unit) accounting.

As shown in Figure 1, cost accounting employs two primary methods, job order costing and process costing, for collecting product cost information. Job order costing is designed to accumulate costs for unique products normally developed to meet customer specifications. Process costing is designed for homogeneous units that are generally mass produced. Under process costing, all the costs are collected for a particular time period without attempting to assign costs to a specific product. The defense industry weapon system business almost exclusively uses job order costing, which collects and assigns costs to a particular contract.

C. COST ACCOUNTING: FINANCIAL MIRROR OF MANUFACTURING

Modern cost accounting is being increasingly criticized for major weaknesses in its ability to accurately identify and measure all relevant costs in the manufacturing process. These alleged shortfalls and inaccuracies in cost information adversely affect cost

management and, ultimately, a firm's competitive position. A review of the development of cost accounting over the past 200 years is helpful in understanding the current wave of criticism.

1. 1800-1925: Focus on Management Needs

Johnson and Kaplan [2] trace the history of cost accounting systems from their origins in the Industrial Revolution through their development today. Their view of history is clear. For about the first 125 years, cost accounting was internally oriented and very responsive to the expressed needs of management. A brief summary of the key events of this period follows.

The birth of the factory in the early 1800s created the management need for cost accounting data. Internal accounting became the primary source of costs for goods and services. Accounting was relatively simple because the typical factory process had only one activity and emphasized internal efficiency, which meant measuring the input/output relationships of direct labor, the dominant cost within the plant. This marked the beginning of the prominent role that direct labor has occupied in cost accounting. At the same time, manufacturers were not concerned either with externally generated reporting requirements or with the formal measurement of the role of capital (both physical stock and financial assets) in the business process.

For most of the nineteenth century, management accounting continued to be most involved in capturing direct material and labor costs to gauge the success of internal operations. When multiple processes were used in these single activity firms, single measurements were usually developed to measure the overall economic activity of the firm. Manufacturing firms typically computed a single conversion cost for each discrete process in the operation. The standards for comparison were not any internally derived costs but rather the prices found for similar items in the marketplace.

In the late 1800s, as business and factory complexity increased, the scientific management school came to the fore and with it, the birth of standard cost accounting. Engineers and accountants used systems analysis to measure the more sophisticated factory with multiple activities. They developed predetermined standards to represent expected usage rates for labor and material consumed in the manufacturing process.

The scientific management period also marked the start of profitability analysis throughout the firm where management wanted to know the relative profit contributions for each of its products. This concept of product costing required assigning overhead or indirect costs to each product in the firm. Previously, management was only concerned with overall company income and not individual product contributions. A notable feature of the early efforts at product costing was the attempt to trace overhead expenses to products by analyzing the specific product support they provided. However, the extensive amount of detailed manual records necessary to support the system resulted in its early demise.

The "new" activity-based accounting systems discussed in Chapter IV basically attempt to do some of the same things engineers and management accountants attempted to do 100 years before them. Today, of course, the big difference is the availability of ultra-high-speed computers to perform much of the needed record keeping and computations.

Johnson and Kaplan point out that shortly after the abandonment of detailed record keeping, financial accountants devised their own methods for product costing necessary for balance sheet and income statement presentation. They elected to allocate overhead on the basis of average gross measures such as direct labor to value inventory for external reporting purposes in the early twentieth century.

In the early 1900s, vertically integrated companies emerged with expanded size and activity. During this period, return on investment (ROI) was introduced as an analytical tool with which to compare the effectiveness of internal company performance with other alternative (external) investments. This necessitated, for the first time, the development of an accounting system for capital assets and related depreciation. During the previous 100 years, detailed records generally were not maintained for plant and equipment. Investment costs were charged directly to retained earnings as quickly as possible rather than expensing them as depreciation and periodically and systematically charging them against income.

The final substantive change in business organizations during this period occurred around 1920 when the multidivisional firm was developed to overcome some of the impediments created by the large bureaucratic and centralized firms. Management continued to rely on the profitability measures to assess company performance. This

necessitated continued use of capital measures, overhead allocation, and direct labor efficiency.

2. 1925-1989: Focus Shifts to Third Party Needs

By 1925, cost accounting, as we know it today, was basically formed. Material and direct labor are assigned directly to specific products,[1] while overhead is typically allocated to products by direct labor. This period also saw the start of a consistent expansionary role by government in establishing accounting requirements through tax, financial securities, and credit policies and rules. Government intervention was instrumental in establishing and reinforcing over time the preeminence of financial accounting in the accounting process. This shift in accounting emphasis forced a gradually increasing reliance on financial accounting for management purposes. Cost accounting, instead of emphasizing information for internal operations, began following more closely the rules of financial accounting to determine product costs.

D. CURRENT COST ACCOUNTING SYSTEMS

The first part of this section describes the cost accounting process found in general industry including defense. The second part describes the overhead accounting systems for the defense industry as represented by the twelve firms IDA has surveyed over the past several years. We would expect to find a similar framework in other than defense companies as well.

1. General Industry Accounting

Costs are generally collected by cost center (functional unit) and cost element, i.e., direct material, direct labor, other direct costs, and overhead and the myriad of their respective subelements. Material, direct labor, and other direct costs can be directly and conveniently traced to a product. Overhead or indirect costs represent all other costs that are generally allocated to a product based on some activity measure, which should have a causal relationship with the overhead costs. The most common bases are direct labor hours, direct labor cost, machine hours, and material costs.

---

[1] Throughout the paper, we use the term product to represent the broad category of output by a company.

Direct labor (hours and cost) is still the primary allocation basis used in industry. A recent survey by Price Waterhouse accumulated data on about 70 Midwest manufacturers as shown in Figure 2 [3]. Over 70% of the firms reported using more than one allocation basis with direct labor being the most used (74%) by a wide margin. Although useful as an indicator, the numbers are somewhat limited since they don't show the dollar magnitude of overhead costs assigned by each allocation method. However, data IDA has collected on selected defense firms show the dollar impact of direct labor allocation as described in Chapter III, subsection B2.

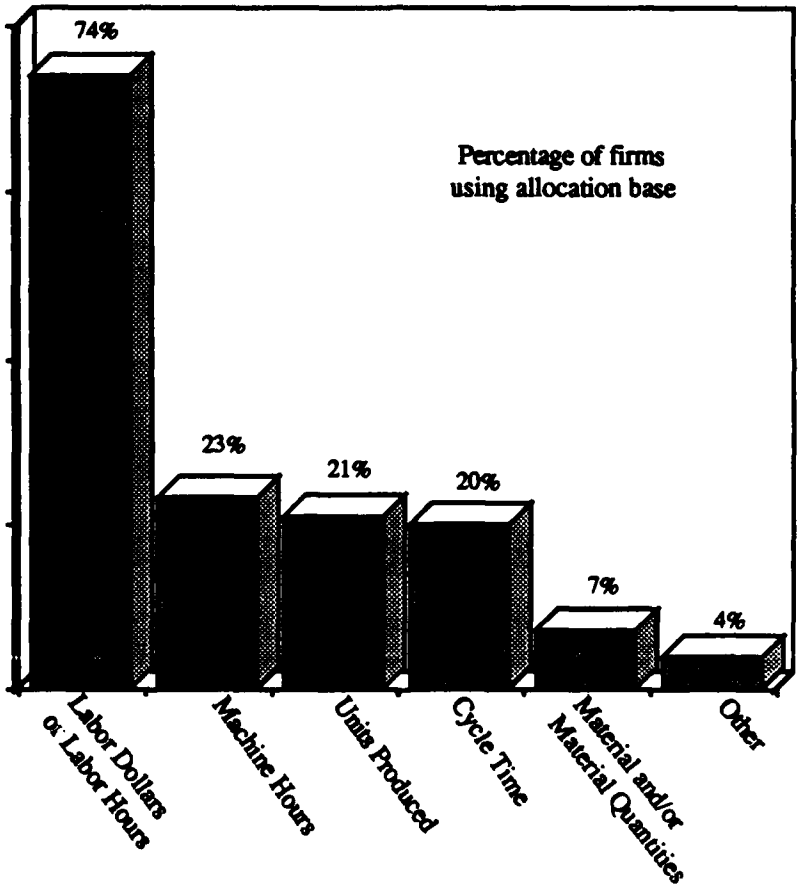


Figure 2. Manufacturing Overhead Allocation Bases

2. Defense Industry Accounting

The following summarizes how overhead is collected and charged within the defense industry. Overhead is first accumulated at the cost center level by cost element or type of expense. Cost centers usually relate to a functional department or some unit within the department. Costs are then broken out into primary and secondary pools. Primary pools represent major homogeneous groupings of cost where each pool can be directly allocated to a product (contract) by a separate allocation basis. Secondary pools typically contain service center costs that cannot be immediately allocated to a product but must first be transferred to primary pools by various methods such as square footage for facility costs and computer time for data processing costs. Manufacturing automation costs in the form of depreciation expenses are also included in overhead and are typically allocated using a direct labor base. After all overhead costs are accounted for in the primary pools, they are allocated to products by the various bases. The allocation process typically revolves around direct labor, which, for the eleven contractors that have provided IDA with specific information, serves as the allocation basis for about 85-90% of all overhead costs.

III. TODAY'S ENVIRONMENT: NEW MANUFACTURING AND OLD COSTS

Cost accounting should provide accurate and relevant data about the manufacturing and supporting processes within the firm to improve resource efficiency and effectiveness in meeting organizational objectives. Section A describes the current manufacturing environment and the development of advanced technologies. In Section B, we examine the changing trends in cost behavior as automated manufacturing continues to supplant direct labor as a major input. Section C evaluates the effectiveness of traditional cost accounting in the current and changing environment. The final section summarizes the potential impact on cost estimating if accounting retains its traditional structure.

A. THE MANUFACTURING PROCESS: TRADITIONAL TO CIM

McNair, Mosconi, and Norris [4] divide advanced manufacturing technologies into two basic segments–advancements or improvements possible in traditional manufacturing processes and flexible manufacturing, which represents the new advanced manufacturing environment.

The traditional manufacturing plant is generally organized by function and focuses on direct labor for input measurement. Improvements in resource efficiency are achieved by making direct labor more productive rather than eliminating it. The philosophy is simply to keep the people and machines going. Recent advances in this arena include Computer Aided Design (CAD), Computer Aided Engineering (CAE), Computer Aided Manufacturing (CAM), and Direct Numerical Control (DNC).

CAD and CAE improve engineering efficiency through the use of computer software. CAD uses interactive graphics to display and visualize design work. CAE uses the geometric model from CAD to perform engineering analysis by simulating performance and technical characteristics. CAM is computer technologies that provide planning, directing, and controlling production equipment used in the manufacturing process. DNC is the use of dedicated computers to control programmable machine tooling.

Flexible manufacturing includes two principal manufacturing technologies–Islands of Automation (IA) and Computer Integrated Manufacturing (CIM). These alternative technologies are designed to change the manufacturing process and not just labor efficiency. The idea, in contrast to the traditional approaches, is simply to replace the people with machines. The traditional approach favored maintaining the labor force during temporary business downturns through inventory build-up which does not immediately hurt profits. McNair et al. also chose to include the Just-In-Time (JIT) procedure as part of the flexible manufacturing category.

IAs are stand-alone automated production processes designed to support a family of products. They normally employ some technologies frequently found in traditional process improvements such as CAD, CAM, and DNC and use robotics extensively to move material through the process. They are referred to as "islands" because they are not integrated into one complete automated system for the factory. CIM provides the IAs with the integrated link for optimum factory perf e. Computers link and control the entire system. CIM not only accelerates cost movement away from direct labor and to capital equipment but also reduces indirect labor as well.

Finally, the JIT approach, as well as total quality management (TQM), is really more of a management philosophy for continuous process improvement that will use the various manufacturing technologies, as appropriate, to achieve higher quality and reduced costs. Continuous improvement requires constant change to eliminate waste whether it be on the factory floor or in the accounting office. For example, one of the objectives of the new automation and management approaches is to reduce inventory levels to zero to avoid product carrying costs. These philosophies have important implications for management accounting, which must provide the kinds of information needed to implement them. This would include such information as value versus non-value costs, more-accurate product costs, more real-time information where actuals become the standard, different methods for evaluating technology proposals, and operational measures to evaluate internal efficiency.

B. CHANGING COST PATTERNS

The expansion of automation in the production process is expected to continue in the long run as rapid technological change permeates both products and services [5]. As automation increases, the need for direct labor, and to a lesser extent indirect labor,

decreases. Also, since current accounting systems include most automation costs in overhead, we would expect to see rising overhead costs. Finally, since automation is ordinarily classified as a fixed cost, the fixed portion of overhead costs should also be increasing.

1. General Industry Trends

McNair et al. [4] portray the changing general cost behavior patterns in Figure 3. The display depicts the significantly increasing technology and engineering cost elements while direct labor declines to the lowest level in the CIM environment.

Berliner and Brimson noted the declining input of direct labor and the related increase in capitalized equipment [6]. Specifically, they stated: "The cost behavior patterns of manufacturing processes are shifting to a lower percentage of direct labor and a higher percentage of other, indirect costs. It is not uncommon to find that direct touch labor accounts for only 8-12% of total cost at many factories. This trend is predicted to be even more pronounced in the factory of the future. A significant portion of total product cost is shifting to equipment-related costs."

Johnson and Kaplan [2] presented similar findings. They point out that direct labor for many manufacturers is now typically 10% or less of total product costs. Miller and Vollman [7], in arguing for the need to manage overhead, show the consistent pattern of rising overhead and declining direct labor as components of value-added costs (conversion costs which consist of direct labor and overhead) from 1855 to 1975. These trends are reproduced in Figure 4.

2. Defense Industry Trends

Since 1981, IDA has been involved in a long-term study of defense contractor indirect costs for the Office of the Assistant Secretary of Defense, Program Analysis and Evaluation (OASD(PA&E)). The results from this effort also show a general trend of increasing overhead and decreasing direct labor, though not as pronounced a one as the levels estimated previously for general industry.

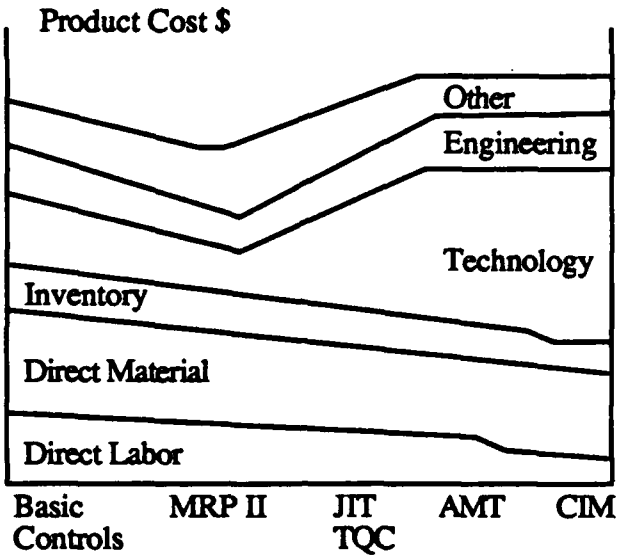


Figure 3. Changing Cost Behavior Patterns

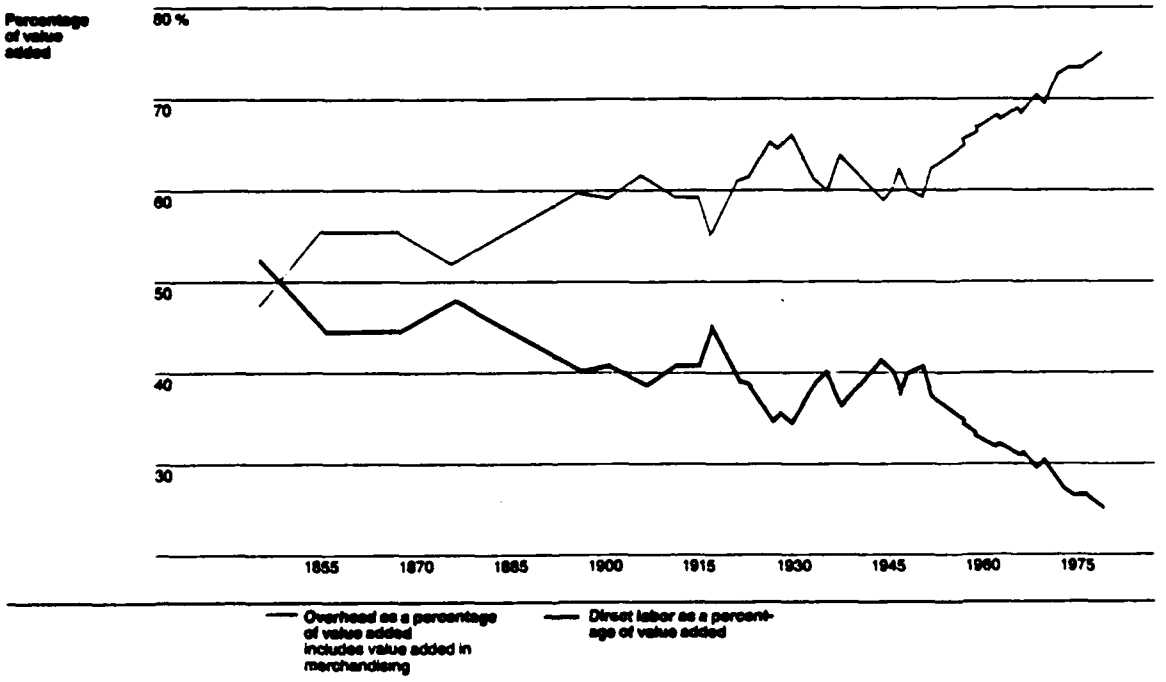


Figure 4. Value Added Trends

In the latest data through 1987 on the eleven aerospace firms studied, direct labor was about 16% of the total cost input per year [8]. The report on the data also noted "that the fixed component of cost is increasing as industry moves more and more towards the automated factory. It is currently estimated to be approximately 27 percent for aerospace firms; it was estimated to be about 15 percent just two decades ago." In 1982 data on a similar group of seven contractors, direct labor was about 20% of total costs [9].

We should also note that the IDA data for direct labor do not include related fringe benefits, which would add about another 25% to the costs and accordingly increase the direct labor percentage share of the data base. We were unable to determine whether the general industry estimates for direct labor included fringe benefits. For comparison purposes, we did not add the fringes for direct labor in the defense figures on the assumption that the general industry data did not include them either.

Several possible explanations have been offered to explain the apparent differences in automation levels between defense and non-defense industry. First, the relative instability of defense work makes investment cost recovery a risky business. It is easier and more cost effective to adjust labor levels to economic conditions rather than dispose of equipment. Second, the quantities procured for major weapon systems are not always large enough to justify new investments in automation. Third, DoD work often entails the development of advanced systems, which require significant engineering and "soft" production at the outset. Finally, the nature of the production process itself, particularly for assembly of aircraft, may require more direct labor participation.

C. TRADITIONAL COST ACCOUNTING: HOW EFFECTIVE IS IT?

There is no one answer to the question regarding the overall effectiveness of traditional cost accounting systems. While cost accounting systems generally follow the framework described throughout this section, the specific systems can vary extensively among industries, firms within an industry, and organizations within a firm. In addition to the technical differences in systems, the subjective evaluations of the individuals involved would also need to be considered. As a result, we would expect different responses across the entire business spectrum.

We believe these reasons warrant additional research and analysis into the viability of traditional accounting systems both by individual firms and various industry groups.

Cooper [10] provides numerous symptoms or indicators an individual firm should look for to determine the effectiveness of their systems. We extracted those symptoms that may be particularly useful for defense industry firms, as shown below:

- Units within a firm developing their own cost systems.
- Accounting personnel spending large amounts of time on special projects gathering financial information.
- Competing firms with much different prices and bids.
- Experiencing increased automation while continuing to use direct labor as the allocation basis.
- Changing use of overhead functions by different products.
- Simplification of manufacturing process.

Cooper points out that the symptoms by themselves do not render a cost accounting system obsolete. An analysis of the underlying conditions that produced the symptoms must be performed before a reasonable evaluation can be made. Finally, Cooper asserts that any cost system should generally have a useful life of 10 years.

Our assessment of traditional cost accounting system effectiveness was limited to reviewing key indicators in the manufacturing environment, as noted in Chapter II and sections A and B in this chapter. Generally, the effectiveness of current cost accounting systems is, at least, questionable for the reasons noted below and discussed in more detail previously in this chapter:

- The modern manufacturing environment is changing dramatically while cost accounting has largely stagnated for the past 65 years.
- Changes in manufacturing are resulting in changing cost patterns with direct labor declining and overhead, particularly fixed overhead, increasing. While we are seeing similar trends for defense, they are not at the higher rates attributed to general industry.
- Accounting emphasis has shifted away from cost accounting to financial accounting. Accounting personnel now devote more of their efforts at following the rules for financial accounting rather than developing relevant and accurate information for internal use.
- The lack of traceability of automation costs to the particular products they support distorts cost driver and product cost information.

- Continued use of direct labor as the predominant basis for allocating overhead in a multi-product and increasing technology environment suggests the lack of sufficient cause and effect relationships between the bases and the overhead costs.

D. IMPACT OF TRADITIONAL ACCOUNTING ON ESTIMATING

We foresee several possible problems for cost estimating if the traditional cost accounting systems continue to exist in their present structure. First, the relevance of the learning curve in a highly automated environment has not been demonstrated. The continued use of models and CERs that revolve around direct labor hours as the primary volume or activity measure for the factory may no longer be appropriate. As technology increases, the correlation between direct labor and cost gradually becomes less meaningful and ultimately irrelevant. Second, product costs may be distorted by inaccurate allocation of overhead costs using a direct labor basis in a high-technology factory. Third, accounting systems are not routinely producing information about cost drivers that are essential to the estimating process, particularly when using a bottom-up approach. Traditional cost systems do not generate information to identify the real cost drivers needed as the basis for predicting costs. This absence becomes more pronounced as a program matures and additional technical and business details become available. During this period, the number of available cost drivers should also increase and serve as the foundation to develop a more accurate and detailed cost estimate.

As a result, cost estimators must use other sources to obtain the needed information. This requires the use of additional resources and time, both of which are usually in short supply. There also appear to be two other risks here. First, all relevant data may not be collected either because the information simply is not available or the analyst fails to identify the appropriate requirement. Secondly, the information may not be as accurate as data subject to the routine checks and balances of a standard accounting system.

In the next chapter, we examine how the new accounting systems expect to fill the void for relevant and accurate cost management information.

IV. NEW ACCOUNTING SYSTEMS

This chapter describes the new accounting approaches, their implementation, and the probable effects on present cost accounting and estimating. Most of the chapter deals with activity-based accounting (ABA), which is the cornerstone of the proposed systems.

A. ACTIVITY-BASED ACCOUNTING

1. Origins

Our survey of current literature and the activities of various professional associations involved in manufacturing and cost accounting issues showed that the focus of the new systems is on ABA. ABA, which is also referred to as activity-based costing (ABC), is a system for collecting and assigning costs to products based on the significant activities that must be performed to produce the output. The basic system is described in detail in subsection 2.

Many of the primary architects of the new approaches appear to have been or currently are associated with the Computer Aided Manufacturing-International (CAM-I) organization. CAM-I is a non-profit company founded in 1972 by U.S. and European companies to advance manufacturing technology [11]. In 1986, CAM-I established a cost management system (CMS) program office to formulate cost approaches in the new automated environment. The program was sponsored and supported by a group of about 30 industrial companies, including several large defense firms, seven of the largest professional accounting firms, and several university and government agencies. Also involved have been some of the key professional accounting associations, including the National Accountants' Association (NAA) and the American Accounting Association (AAA).

The conceptual design of the CAM-I CMS work to date is contained in reference [6], and includes a new cost accounting model predicated on activity-based accounting. We must note that CMS is much more than an accounting system that is the primary subject

of this paper. The accounting portion is just one of the four recommended systems along with an engineering/manufacturing model, a performance measurement system, and an investment management model. The four systems are interrelated and require activity-based accounting information to function completely. While there are many other books and articles offering new cost accounting systems, they are generally consistent with the general framework and cost principles outlined by CAM-I book. Therefore, our emphasis will be on the CAM-I effort and supplemented, as appropriate, by the work of other prominent leaders in the new accounting movement.

2. Description

ABA involves a different way of measuring how resources are consumed in an organization. CAM-I describes the overall framework as one where products require activities for output and activities consume resources to operate. This view contrasts with the traditional accounting perspective where products consume resources. An overview of ABA follows.

Every business organization establishes management objectives, whether they be formal or informal, that should be achieved to promote the organization's operational and financial well being. The organization must perform various activities to attain these objectives, thereby consuming resources and causing costs to be incurred. Accounting by activity is the new and additional dimension for traditional accounting. What exactly is an activity? CAM-I defines activities as "those actions required to achieve the goals and objectives of that function." We extended that definition by adding that an activity should represent a significant work effort that represents a major and essential operation of the organizational unit in the production and delivery of goods and services. Several examples of activities that can be expected to be found in a manufacturing operation are listed in Table 3. Any one activity may be performed in several different organizational units, and any given unit may perform multiple activities.

Table 3. Activity Structure

Activity	Output Measure–No. of:	Allocation Basis–Cost Per:
Placing an order	Orders	Order
Receiving material	Receipts	Receipt
Distribute material	Units sold	Unit
Set-up machine	Set-ups	Set-up
Machine usage	Hours	Hour
Maintain equipment	Machines	Machine
Process special orders	Special orders	Special order
Training	Hours	Hour
Programming software	Lines of code	Line

Some activities that entail costs may also be characterized in terms of outputs they produce. Some examples of such activities, which can be referred to as cost drivers, include expediting, rescheduling, set-ups, engineering change orders, and scrap and rework. The primary purpose of the new accounting systems is to accumulate costs by significant activities while identifying major drivers that cause costs to be incurred. This goal should be particularly useful for cost analysts in developing estimating relationships at a detailed level. It also seems possible to form families of activities and related cost drivers, which would help estimators develop the broader parametric relationships. For example, it may be possible to forecast total overhead costs for a particular product based upon a significant cost driver, such as the number of orders processed for that product. This might be displayed in the form of a sample regression equation as follows:

$$Y = a + bG + cS$$

where

- Y is the dependent variable or total product overhead costs .
- G is the number of general product orders processed during the period
- S is the number of special product orders processed during the period
- a is the intercept
- b is the regression coefficient of G
- c is the regression coefficient of S.

As in traditional accounting, costs are collected at the cost center level by cost element. ABA also aggregates cost by activity at the cost center level. Cost centers should increase and change under ABA to segregate centers by different processes and machine groupings. The major cost elements (and related subelements) found in traditional cost accounting (i.e., material, direct labor, other direct, and overhead) remain but are accumulated by activities.

ABA also adds a new cost element, direct technology, for automated manufacturing equipment that will be charged directly to the related products. Traditional accounting usually buries automation costs in overhead costs, which are then allocated by direct labor. In a highly automated environment, technology will replace direct labor as the principal activity and cost driver in the manufacturing process. This will necessitate developing new cost estimating methods and new data bases to supplant the labor-driven structure. Contractor cost reporting systems such as the Contractor Cost Data Reporting (CCDR) system will also have to be substantially modified.

The costs included in technology will be greatly expanded over traditional asset costing. Asset costs will include original purchase price and start-up costs as found in today's system. ABA adds interest costs and a current replacement price adjustment to arrive at total asset cost. Both methods of accounting deduct residual value to determine the depreciable basis. In addition, traditional depreciation methods which are tied to fixed economic time periods largely will be replaced by appropriate value added rates that reflect uses in production such as equipment hours. As a result of the ABA adjustments, depreciation costs will be significantly greater and will vary with production volume as opposed to being fixed over time as specified in traditional accounting.

Overhead should be significantly less under the separation of technology as a direct cost element and the expanding automated environment. In addition, overhead allocation will only occur after reasonably trying to trace the costs directly to the products or processes they support. Increased traceability reduces overhead to avoid the potential distortions resulting from the allocation process. Overhead typically will be allocated to products by an activity or cost driver measure that reflects the cause or reason the overhead cost was incurred. Table 3 shows some representative output measures along with their corresponding allocation bases. The basis is simply computed by adding all the cost elements across all cost centers for a particular activity and dividing by the output number

to arrive at an average cost per activity. Some examples of allocation bases are the cost per purchase order for the receiving department or the cost per training hour for any departmental training.

3. Other Key Features of ABA

Several important principles inherent in the new ABA systems are major departures from traditional accounting. In this section, we describe some of the more important differences likely to affect defense work. First, ABA will identify and segregate non-value-added costs to highlight them for potential reduction and/or elimination by management. Non-value-added costs are normally those kinds of activities that do not affect the essential properties of a product and can be eliminated without significant consequence. Examples of non-value-added costs are moving, storage, inspection, and rework. From a financial perspective, such costs can also be viewed as any activity whose cost exceeds the benefit derived. We should note that non-value-added costs are the principal targets for savings under the DoD Could Cost program that was formally introduced by the Under Secretary of Defense for Acquisition in May 1988. Second, product costs will be accounted for over a longer period of time, which ideally is the entire life cycle of the product. Reporting periods will be based on internal needs for information and will incorporate longer periods consistent with the product life cycle. Traditional accounting has emphasized much shorter time frames for measurement – monthly, quarterly, annually, and similarly abbreviated reporting periods. These are financial accounting conventions largely followed to support external requirements rather than internal management needs. Third, all costs that have future benefits will be considered investments and charged to expense over their period of contribution. Examples are personnel training and software costs for information systems regardless of financial accounting conventions. Fourth, an imputed cost should be computed for maintaining inventory based on some measure of the organization's cost of capital.

Finally, Kaplan and Cooper [12] advocate assigning all but two categories of cost to final products via activity accounting, i.e., excess capacity costs and research and development (R&D) costs for totally new lines and products. This is an important difference from financial accounting, which only includes manufacturing overhead in product costs. General, administrative, and selling expenses are considered period costs and are not charged to products in traditional accounting systems. Kaplan and Cooper

recommend that costs associated with excess capacity be treated as a period cost with its own separate line item. This practice will preclude erroneous interpretations regarding manufacturing efficiency that may result when idle capacity costs are assigned to products. This procedure contrasts with much of current traditional industry practice that allocates capacity costs to individual products. In the case of R&D, all costs should be treated as an investment and amortized over the life cycles of the products as opposed to financial accounting, which requires R&D to be expensed as they are incurred. Kaplan and Cooper recommended that only R&D costs related to already existing product lines would be assigned to products. The remaining R&D costs for new products would then be amortized as period costs over the average life cycles for their products.

Traditional cost accounting also places much emphasis on categorizing costs as direct and indirect and as fixed or variable. In the new accounting environment, these distinctions will become more obscure and much less relevant. Indirect costs in traditional cost accounting are important for cost allocation to products. The increased traceability and more cause and effect allocations of costs obviate much of the need for the direct and indirect distinction. The conventional fixed and variable breakout also becomes less important in the new environment. Kaplan [13] points out that fixed costs increase substantially and variable costs all but disappear in the advanced technology environment. The remaining variable costs are basically material, which includes subcontracts, and utilities necessary for equipment operation. All the remaining costs, including most of the labor costs, are fixed. As a result, cost estimators could no longer use the historical models, estimating relationships and data bases used to predict fixed costs. We developed a summary of the major differences between traditional cost accounting and ABA, which can be found in Table 4.

One other area warrants mention here, the manufacturing operating environment, which is anticipated to be one of continuous improvement. Many of the current cost accounting systems extensively use standard costs both for costing and variance analysis to assess actual cost performance. In the continuous improvement environment, actual costs will likely become the standard with the objective to be constantly more efficient to continuously reduce actual costs.

Table 4. Traditional Versus Activity-Based Accounting

	Cost Accumulation	
	Traditional	Activity-Based
Cost element		
Material	X	X
Direct technology		X[a]
Direct labor	X	X[b]
Other direct	X	X
Overhead	X[c]	X
Cost center	X	X
Activity		X
Value vs. non-value added		X

[a] Capital assets are valued at current replacement cost as opposed to the historical costs shown in traditional accounting systems. ABA depreciation is calculated based on production life rather than the traditional physical life.

[b] The distinction between direct and indirect labor may no longer exist. Direct labor may simply be included as labor in a technology cost center.

[c] Direct labor, as reflected in either hours or costs, is the predominant allocation basis in traditional system. ABA envisions less overhead that is allocated more effectively by using many more overhead rates related to cost drivers that better reflect causal relationships between costs and products.

B. IMPLEMENTING NEW SYSTEMS: WHERE AND WHEN

We are seeing more and more professional conferences, seminars, and meetings dealing with the demand for accounting change, principally in the form of activity-based accounting. A growing consensus seems to be emerging from industry, academia, and to some extent, the government.

In this section, we review the implementation status of new ABA systems in terms of the extent to which new systems have already been implemented and the plans for future implementation. We also briefly describe some of the more important implementation issues dealing with resources and time. The final part of the section assesses the implications for DoD.

1. Systems Already Implemented

IDA recently surveyed major corporations to identify companies that developed and instituted new cost structures similar to those advocated in ABA. The survey results [14] showed that while several companies had initiated pilot projects for a portion of their

operations, no organization had fully implemented ABA. For example, General Motors began considering ABA in 1986 and is currently piloting the new approach at 19 different locations [15].

These results were subsequently confirmed during an IDA-sponsored conference on cost/performance measurement held on May 31 and June 1, 1989 [16]. Conference participants included key leaders from industry, academia, major accounting firms, professional associations, and the government. They concluded that a major barrier to the implementation of new systems was the total absence of models representing companies that had successfully implemented an ABA system. As a result, the participants agreed on the need to fill the model void by recommending that DoD and industry jointly initiate pilot programs to demonstrate the value and the viability of the ABA concepts.

2. System Plans: Resource and Schedule Requirements

These factors are major considerations in ABA implementation decisions. Conversion from a traditional to an ABA system appears to be a relatively time-consuming and expensive undertaking. Although there are no actual data available on the costs and time involved in implementing a company-wide system, several individual companies have estimated these requirements. While these estimates are only rough approximations, they do provide some insight into the magnitude of the conversion work. For example, representatives from a major consulting organization involved in ABA projects recently provided us with informal estimates. They projected that full ABA implementation by a company with $1 billion in sales would take about three to four years and cost somewhere between $15 million and $40 million. We also received an estimate from the chief financial officer of a company with several billion dollars in sales that performed an internal study on implementation costs. This source estimated that it would cost the firm approximately $150 million to convert totally to ABA.

The above estimates were predicated on full ABA implementation. An alternative and more likely approach discussed at the cost/performance measurement conference [16] would be some form of incremental conversion where ABA would be phased in. Phasing could be based on organizational units within the company or by modules within the ABA system or some combination thereof. This would allow time for further developing, testing, and refining the system while gaining some of the ABA benefits in the interim.

3. Implications for DoD

The initial estimates for the costs and time requirements described above indicate that ABA implementation on a wide scale is still several years away. The situation for the government in general and for the DoD in particular is compounded by the various government laws, regulations, policies, and practices dealing with government contracts. Defense contractors must not only satisfy the externally imposed accounting rules that non-defense firms are subject to but also have the added burden of federal and DoD contract compliance.

Rezaee [17] outlines the basic requirements for accounting systems that support performance of government contracts. He notes that a contractor generally can use any accounting system providing it meets certain standards. These standards are those established in Generally Accepted Accounting Principles (GAAP), the Cost Principles in Federal Acquisition Regulation (FAR) Part 31, and the Cost Accounting Standards (CAS). Failure to comply with any of these requirements can result in major penalties such as ineligibility for future contract awards and pricing adjustments and cost disallowances on existing contracts. In addition, the contractor is still required to change the accounting practice to comply with the standard.

As a result of the potentially severe hardships associated with non-compliance, defense contractors are wary of the risks involved in changing already accepted accounting practices. In discussing ABA implementation issues, the greatest concern of defense contractors attending the cost/performance measurement conference was the effect on existing contracts where costs were accumulated based upon another accounting system. The industry view was that the additional and/or different information made available through ABA should not be used to retroactively penalize the contractor. Without such assurances, ABA is a high-risk project for defense contractors. These concerns have created another major barrier, which must be dealt with by the government or further delay implementation in the defense industry. Since full implementation of ABA is likely to be at least several years away, the DoD cost estimating community has ample time to plan for it. Studies and analyses regarding the need for model and data base revisions can be made early on to facilitate the transition.

C. EFFECTS OF ABA ON COST ESTIMATING

Cost estimators can expect to find several major differences if ABA is implemented.

1. Changing Costs to Mirror New Technology

Costs at every level of the weapon system work breakdown structure (WBS) will better mirror the underlying manufacturing process. This includes costs accumulated for the total weapon system, for individual contracts within a system, and for related components and parts. New cost elements, such as direct technology, will also provide better descriptions of manufacturing costs. This should improve parametric and detail estimating methodologies and place more representative price tags on competing weapon systems for consideration in the DoD planning, programming, and budgeting system.

2. Better and More Detailed Information About Cost Drivers

The added breakout by activity and non-value-added costs will result in more data about cost drivers. The activity structure can also serve as building blocks to develop higher and broader cost driver information as found today in some of the cost drivers involving physical and performance characteristics. Also costs should better reflect the manufacturing environment, e.g., the direct technology will largely replace direct labor as the primary activity in the highly automated environment. Less overhead will have to be allocated as costs are increasingly traced to the products they support. The use of cost centers to identify similar automated processes also increases the opportunity to develop more effective cost driver information.

3. Obsolete Data Bases, CERs, and Models

Data bases, CERs, and models that have their foundation in historical direct labor hours may no longer be relevant. Improved cost driver information may also render CERs and models obsolete. Past contract costs for specific weapon systems will be less useful in estimating new contract costs because cost collection, classification, and allocation procdures may change the way individual contracts are priced. Also, historical overhead rates lose their significance as overhead allocation declines and the activity bases change.

4. Lower Estimates Due to Increased Potential for Cost Reductions

ABA by itself saves nothing; however, it establishes an information framework with the potential to produce needed changes. The combined effects of developing more useful cost information about drivers, non-value-added effort, and product costing, among others, complement and enhance an overall business environment that emphasizes efficiency through automation and continuous improvement. Cost information is most valuable when it contributes to improvements in the underlying processes that result in costs being incurred. Estimators will have to adjust their cost predictions to allow for probable reductions.

Finally, we should note that while ABA will produce more information, the availability of that data to the government and its surrogates is an unknown factor. Presumably, the government and the contractors will mutually agree on data access if and when there is agreement to proceed with ABA.

V. FINDINGS AND RECOMMENDATIONS

A. FINDINGS

Traditional cost accounting recently has been the object of extensive criticism because of its inadequate representation of manufacturing costs. New accounting approaches have been proposed to regain the lost insight into internal organizational operations. These new approaches have important implications for the DoD cost estimating community, a large user of accounting data.

This review resulted in seven principal findings, which are summarized below:

- The manufacturing environment in some firms has changed with the growth of automation and new management approaches and the commensurate decline in direct labor.
- Traditional cost accounting does not adequately mirror the new manufacturing process in terms of product costs and cost drivers.
- The learning curve theory may not be relevant in a highly automated environment.
- Cost analysts, who rely on accounting to provide manufacturing cost data, must compensate for traditional accounting shortcomings to maintain and, perhaps, improve its capability to predict costs.
- New accounting systems, as represented in the activity-based accounting approach, have been proposed to better reflect the manufacturing environment. Such systems have the potential to improve DoD's ability to predict costs.
- ABA provides better and more detailed information about cost drivers for bottom-up costing and may be used to build more aggregate drivers for parametric estimating.
- Current data bases, CERs, and models may become obsolete or less relevant as technology changes and ABA provides new cost data.

B. RECOMMENDATIONS

Our review of the available literature, participation in related conferences and discussions with knowledgeable individuals involved in the new cost accounting movement lead us to propose four principal recommendations for consideration by the OSD cost estimating community.

- Promote training in ABA and the new manufacturing environment for those most likely affected.
- Encourage and participate in further research, development, and testing of ABA.
- Evaluate the relevance of current learning theory in the new automated environment.
- Perform a detailed assessment of the effect of ABA on the present cost estimating structure.

The remaining part of the chapter briefly discusses the above recommendations, which are generally listed in their preferred time sequence.

1. Promote Training in ABA and New Manufacturing Environment

The recent emergence of ABA as a reasonable and potentially valuable alternative to traditional accounting has important implications for DoD. However, knowledge of the new accounting system appears limited and confined to small and fragmented segments of the government. Several disciplines, including cost estimating, will be heavily affected by ABA implementation. Cost analysts should learn the theory of ABA either by attending a commercial or government-developed training program. Analysts should also learn the new technology appropriate for the weapon system being estimated. Such training would be helpful in estimating costs and in better understanding the objectives of ABA. It would be very useful if all the key personnel would receive training early so that they can actively and knowledgeably participate in the ABA development process.

2. Encourage and Participate in Further ABA Development

ABA is still largely in the concept development phase. While the potential exists for major improvements, the true value of ABA can best be demonstrated in a live operational environment. Implementation of ABA in the commercial sector should be closely

monitored to identify success/failure and lessons learned. We also strongly encourage DoD to establish an ABA test project with a minimum of three pilot programs within the defense industry. The selected programs could be directed at the major phases of a program life cycle where there are different cost and contract implications, i.e., concept validation/demonstration, full scale development, and production. Other factors such as service representation, weapon system type, and contractor capability should also be considered in the selection process. The funding of the pilot projects by DoD should not be an issue. Several contractors have informally expressed willingness to participate at no cost to the government provided that they will not be penalized on existing contracts because of new ABA-generated information. Participants in the pilot projects must carefully identify and document the changes required to the Cost Accounting Standards (CAS) and other government regulations.

Finally, the cost estimating community should play an active role in the pilot projects. Such involvement will necessitate developing new parametric and bottom-up cost relationships for the pilot programs. This will provide the opportunity to develop test estimates based on the new accounting data, which can then be compared with the results achieved using traditional accounting data.

3. Evaluate Effect of New Technology on Learning Curve Theory

Learning curve theory, which is largely based on direct labor, is an integral part of many current cost estimating methodologies. Its continuing value in an environment of increasing automation and declining direct labor is questionable. Therefore, we recommend an analysis of all the possible assumptions involved in current learning curve improvements be made to determine the relevance of the theory in the new manufacturing environment. The analysis also should include a review of defense contractor capabilities to determine the current extent of automation and plans for future technology.

4. Assess Effect of ABA on Cost Estimating Structure

This paper provides only a summary view of the new accounting approaches. A more detailed review of the specific ABA changes should be made and related to existing data bases, cost estimating relationships, models, and formal guidance used throughout DoD. Extensive study should be made of ABA cost drivers. It should be determined which ones can be used and which ones are too detailed, and new higher level cost drivers

should be developed. Cost elements of ABA should also be carefully reviewed. If direct labor is to become unimportant, what cost elements will be important? This will entail extensive involvement by the cost estimating community in any DoD project designed to consider ABA implementation, including the recommended pilot programs above. Finally, an ABA implementation plan should be developed in conjunction with all the recommendations. The plan must translate the primary results from the research, analysis, and training efforts into objectives and tasks along with appropriate schedule and task responsibility information.

REFERENCES

[1] Manufacturing Studies Board. *Toward A New Era in U.S. Manufacturing.* National Academy Press, 1986.

[2] Johnson, H. Thomas, and Robert S. Kaplan. *Relevance Lost: The Rise and Fall of Management Accounting.* Harvard Business School Press, 1987.

[3] Randall, Robert F., ed. "News: Midwest Firms Change Cost Systems." *Management Accounting*, July 1989, p. 11.

[4] McNair, C. J., William Mosconi, and Thomas Norris. *Meeting The Technology Challenge: Cost Accounting In A JIT Environment.* National Association of Accountants, 1988.

[5] MIT Commission on Industrial Productivity. *Made In America.* MIT Press, 1989.

[6] Berliner, Callie, and James A. Brimson, eds. *Cost Management for Today's Advanced Manufacturing.* Harvard Business School Press, 1988.

[7] Miller, Jeffrey G., and Thomas E. Vollman. "The Hidden Factory." *Harvard Business Review*, September-October 1985, p. 143.

[8] McCullough, James D., James K. Bui, and Thomas P. Frazier. "Defense Contractor Indirect Costs: Grumman Aerospace Corporation, Grumman Corporation, 1973-1987." Institute for Defense Analyses, Paper P-2280, August 1989.

[9] McCullough, James D., and Stephen J. Balut. "Defense Industry Indirect Costs: Trends, 1973-1982." Institute for Defense Analyses, Paper P-1909, March 1986.

[10] Cooper, Robin. "You Need a New Cost System When." *Harvard Business Review*, January-February 1989, pp. 77-82.

[11] Williams, Kathy. "CAM-I: On the Leading Edge." *Management Accounting*, June 1989, p. 18-2.

[12] Cooper, Robin, and Robert S. Kaplan. "Measure Costs Right: Make the Right Decisions." *Harvard Business Review*, September-October 1988, pp. 96-103.

[13] Kaplan, Robert S. "Yesterday's Accounting Undermines Production." *Harvard Business Review*, July-August 1984.

[14] Cheslow, Richard C., and James D. McCullough. "Cost Considerations of an Integrated Design-Manufacturing-Support System." Institute for Defense Analyses, Document D-619, June 1989.

[15] Smith, Roger B. "Competitiveness in the 90's." *Management Accounting*, September 1989, pp. 24-29.

[16] Cheslow, Richard C., and J. Richard Nelson. "The Executive Workshop on Cost/Performance Measurement, Volume 1: Executive Summary." Institute for Defense Analyses, Paper P-2321, October 1989.

[17] Rezaee, Zabihollah. "Designing Cost Accounting Systems for Government Contractors." *Armed Forces Comptroller*, Winter 1989, pp. 20-23.